RE: Addition of a Groundwater Monitoring Campaign to ARM Study

Questions submitted to EPA for review by:

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Observation of the methods and results of groundwater monitoring studies has raised many questions regarding feasibility, accuracy, and applicability of this work to our current study. We have many concerns associated with the proper installation and sample area size of monitoring wells. While we are not opposed to adding a groundwater monitoring campaign to our study, we want to make sure it is not going to waste valuable resources or add ineffective workload, and that it can be done thoroughly and accurately. It must be recognized that variable soils and topography both at the surface and subsurface will challenge plot design. The use and validation of the ARM protocols are being pushed forward to help producers make the right decision of when to and more importantly, when *not* to apply manure. Our current monitoring design will verify both; we have reservations with the need to show that applications are affecting the ground water to protect that resource. The methodology is to measure the nitrogen traveling beyond the root zone, and determine what affects changes in management can have to reduce that amount. By addressing the questions and concerns we have listed below, we would have a better idea of the validity of the groundwater well monitoring method, as well as confidence in the design and installation. While some of the questions may only be answered by data collection, it is important to postulate an answer and consider all aspects of the study design in development of a scope of work.

The following are questions that must be answered or addressed by a groundwater monitoring study:

Can nitrogen applications in excess or limit of crop utilization to a single area (e.g., a 10 acre field) be accurately observed in the groundwater directly below it? What factors may potentially interfere with accurate observations? What are the constraints to accurately characterizing a single (10 acre) plot?

What is the level of contribution of background sources to the groundwater below a (10 acre) test plot? Can the background be accurately observed/measured at various depths? What is the process for accurately measuring groundwater flow direction to deduce background sources (e.g., pressure transducer, piezometer)? Can we effectively mitigate for their influence? For example, would addition of tracers help to segregate current and past applications on the site or transport from locations up gradient of study site?

How is monitoring well location best and most thoroughly determined (i.e., contour assessment, modeling, groundwater flow characterization, etc.)? What are the potential struggles/issues with a poor well location placement?

How many monitors are needed in a 10 acre plot to give an accurate representation of the contribution of nutrients from *only* that plot to groundwater? How many background monitors are needed to accurately characterize the incoming groundwater nutrient levels?

What is the degree of influence of septic systems, irrigation wells, or water bodies on the seasonal velocity (speed and direction) of the water table flow? How do we mitigate against this?

What is the time lag between what happens on the surface of the field and what is observed in the groundwater at any time of the year? Is permeability the best (or only) way to determine this, or is there another method?

An increase in groundwater nitrate levels will be obvious to observe, but will a decrease be equally observable? If background levels are coming in at 10 ppm, will the only observable change be no contribution or an increase in contribution? (Lysimeter data may be used to provide an estimated background or base-level for nitrate loss from the control vs. ARM field activities to base change off of).

Will nitrate levels naturally increase with a rise in seasonal water table due to nitrate storage in the soil? Or, is there a dilution effect of nitrate with rising water table levels?

Groundwater is typically not measured closer than 24 inches from the surface. What is the constraint with measuring closer to the surface? If the water table is higher than this, is sampling prohibited?

Is it appropriate to only sample the top couple of inches of the water column in the monitoring well? Is there any type of vertical mixing, striation, or settling of the analytes in the water column that may prevent accurate sampling?

How much influence does denitrification have on groundwater nitrate levels and how do we measure that? Is depth of water table a factor in the denitrification rate? In deep wells we see little to no nitrate compared to a shallow well at the same location. What are the processes attributed to this and how can we account for it?

How frequently do wells need to be monitored to accurately assess the transport of nitrate into the groundwater based on activity on the surface? Daily, weekly, monthly, quarterly? Should sampling be based on precipitation events, activity, or other? If so, what are the parameters to trigger sampling?

How correlated are measured passive lysimeter, soil, and groundwater nitrate levels? Have any studies been conducted to look at this? Should the difference between the lysimeter N level and the groundwater N level equal the soil N level? Is the difference in nitrate between the lysimeter and groundwater representative of the amount of N immobilized, mineralized, or in another N form in the soil?

How correlated will the mass-balance approach of nitrogen loss being conducted by the lysimeter method be to the measured levels in groundwater? It is appropriate and/or scientifically valid to compare these two values?

Besides nitrate levels, what type of data can we collect from monitoring wells that will be valuable to the objectives of this project? Please explain how.

Can another analyte such as chloride (naturally present) or bromine (added) be used as a marker for nitrate to predict/track denitrifucation, transport, or quantity? Can collection and analysis of these analytes be used to compare the lysimeter and well methods? If so, what is the best way to do this?

What do the groundwater data conclude? How do these data fit into the objectives of the study? For example, do they give us a direct, real-time correlation to the timing of manure application, the rate of manure application, or the influence of soil moisture and precipitation levels on nitrate transport? Or, are they better suited to monitor groundwater analytes in a larger area and are not appropriate to compare to surface activities or the collected lysimeter data?

Please submit answers or follow up questions directly to:

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